Moisture in Compressed Breathing Air System

Excess moisture in your compressed air system can cause problems both within the system itself and for the applications that utilize it. Appropriate maintenance and the use of air dryers can remove moisture from your air and extend the life of your system.

What Causes Moisture in Compressed Air?

Moisture is an inevitable byproduct of compressed air. All air contains a certain amount of water vapor. The volume of water held by the air varies with temperature and pressure; the higher the temperature, the more water air is able to hold. That's why humidity tends to be higher in warmer months than in the winter.

An air compressor works by squeezing air into a smaller volume under high pressure. When a compressor draws in air, the air is compressed to about 12 times normal atmospheric pressure. Pressurized air is not able to hold as much water. As the pressure increases, water vapor condenses back into a liquid. The water in the air has to go somewhere, so it forms a condensate inside the air compression system. Condensate can form inside the air compressor in the receiver tank, and in the lines and other system components. If water is allowed to accumulate, moisture may get pulled back into the compressed air stream.

Condensation is a problem for compressed air systems in all seasons, but hot, humid air in the summertime can result in the production of large volumes of excess water. On the other hand, cold temperatures in the winter can reduce the efficiency of evaporation, allowing moisture to accumulate over time even when humidity is low. It is essential to remove excess moisture from your air compression system in all seasons to avoid problems.

Problems Caused by Moisture in Compressed Air Systems

Excess moisture causes a number of problems for your air compressor and its components. The most serious is corrosion. Corrosion is a chemical reaction between a metal, oxygen and water; this is why metal rusts when it comes in contact with water. Keeping your compressed air system clean and dry—including the air compressor motor, tanks, lines, valves and electronics—is essential for system longevity.

Water in compressed air systems can result in other problems for your system, too. Excess water may cause water hammer events, which can damage equipment and piping (you may hear this as a knocking sound in your air compressor pipes). Liquid water can also block control lines, which prevents instruments from reading and actuating properly. In cold temperatures, ice can form inside the system. Ice may clog filters and block intake or drain valves, negatively impacting system performance. Because water expands when it freezes, ice formation can also crack pipes and other system components.
Excess moisture in the compressed air stream can also be highly problematic. Liquid water or high humidity in the compressed air stream may interfere with proper lubrication

or lead to corrosion of air tools. Particulate from rust that develops in air supply lines can become mixed with the air stream and damage equipment or foul production processes. If you are using a compressor to spray paint, water can cause negative visual and texture effects in the finish. Other applications where moisture in air compressors is a real nuisance include sand and other material blasting, pneumatic tools, CNC machining centers, robotics, air cylinders and valve operation.

How to Remove Water from Compressed Air

While it's impossible to prevent moisture from entering your air compressor, you can get rid of most of it. This is done in stages using different components throughout your system. This may include a combination of mechanical separation and refrigerated or desiccant air dryers. Read more about the difference between refrigerated and desiccant air dryers.

Draining the Air Receiver Tank

It's important to know how to drain your air compressor. The first place that moisture condenses is in the air receiver tank. When compressed air emerges from the pump, it's hot. This temporarily keeps the water in its vapor state. As it makes its way to the receiver tank, the air cools down, allowing excess water vapor to condense back into a liquid. The first step in your moisture control plan is to ensure that excess water is drained from the air compression system on a regular basis. This can be accomplished most simply with a manual drain valve. Water should be drained at least once daily if draining manually. Automatic timer-based and pneumatic drain valves eliminate the need to remember to drain the receiver tank. An auto drain valve will automatically open to release excess liquid on a regular schedule or in response to a sensor. This can be a valuable benefit if your maintenance staff is stretched thin or if the air receiver tank is not in an easily accessible location. Draining the air compressor will not remove water that is still held as vapor in the air, but it will prevent excess liquid from building up within the tank and air supply lines.

Water Separator Filter

The next stage of moisture removal for your air compression system is mechanical separation. This is done with a water separator filter (also known as a filtration water separator). These systems look like an in-line air filter or air compressor oil separator. The filter removes large amounts of moisture from the air supply with centrifugal force. Typically, a water separator filter will remove between 40 – 60% of the water from the air. Depending on your application, this may or may not be dry enough.

Refrigerated Air Dryers

If further moisture removal is needed, look next to refrigerated air dryers. These dryers work by chilling the air, much like your air conditioning system. Remember that colder air holds less moisture than warmer air. The refrigerated air dryer chills compressed air to

roughly 33-40°F. As the air cools, excess water vapor condenses back into a liquid. The liquid collects in a water trap and is removed through an automatic drain valve. The dry air is then reheated to room temperature before it re-enters the production lines. Compressed air that is dried by this method has a dew point (the temperature at which condensation will form) between 33-40°F, which is low enough for the majority of industrial compressed air applications.

Desiccant Air Dryers

Desiccant air dryers are used for applications that require very dry compressed air. These dryers work by removing water from the air through a chemical process. A desiccant is a solid that reacts chemically with water to form a bond. Most desiccant air dryers use activated alumina or molecular sieve desiccants. Compressed air is passed through a tower containing the desiccant material using a blower. Some desiccant air dryers also use heat. Depending on the model, desiccant air dryers can get compressed air down to a -40 to -100°F dew point, removing nearly all water vapor from the air stream. This is necessary for processes that require ultra-dry air or are operating at less than 34°F. These dryers use more energy than other drying systems and also consume between 5-18% of the compressed air supply in their operation. But if ultra-dry air is needed, they are the most effective method available to remove moisture from your air compressor and compressed air supply.

How Dry Does Compressed Air Need to Be?

There is no one-size-fits-all answer to designing a system to remove water from compressed air. The right solution for you will depend on several variables, including your system usage, the atmospheric and environmental conditions in the region where you are located, and the indoor environment in which your system is installed and operated.

It also depends on how you are using compressed air in your facility. Some applications, such as painting, printing, and some kinds of air-powered instruments, are highly sensitive to moisture in the compressed air stream. For these applications, you may need a multi-stage solution that removes as much water as possible from the air.

For other applications, the moisture content of the air stream may not be as critical. Simply draining excess water out of the receiver tank and lines on a regular basis, and perhaps adding a mechanical separator, might be enough.